The Relative Importance of Perception, Embodiment, Metaphors, and Ethics for Cooperative Human-Machine Coexistence

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Abstract: In applications of soft computing, one question raised is the extent to which artificial intelligence (AI) and human intelligence (HI) share similar quantitative or qualitative properties or both. Recently, we have argued that phenomenology emphasizes first-person experience as one of the central differences between AI and HI. Presently, we expand this argument to include perception, embodiment, metaphors and ethics. For experience to occur, the experiencing entity needs a body, which contributes to the development of the first-person perspective. The work of Gibson and Merleau-Ponty supports this view by providing alternatives to information processing and behavioral models in the study of perception. Similarly, Lakoff's central metaphors are compelling in the field of linguistics. In case of AI, however, embodiment seems not to be apparent. As a result, AI has difficulty understanding natural language because perception and many metaphors are expressed and learned in terms of the body. The implication is AI can thrive as long as long as there is HI, which corroborates our view of human-machine coexistence. Furthermore, and not necessarily paradoxical, the humanistic endeavor of ethics may be more suitable for AI in the case of war robots that successfully adhere to universal laws. The integration of AI and HI is accomplished by having humans as the source for first-person experiences, whereas machines are the extended minds of humans.

1 INTRODUCTION

Soft computing is a bundle of methodologies that are often synergistic, working together to supplement each other and provide flexible information processing capability for handling vexing real-life scenarios (Zadeh, 1994; Mitra et al., 2002). The field of soft computing encompasses three main branches of research and applications: (i) neural networks, which serves as a framework for modeling how brains function, (ii) fuzzy systems, which models linguistic aspects of how humans describe the world around them, and (iii) evolutionary computation, which accounts for variation and natural selection in the biological world (Keller et al., 2016).

Research on soft computing aims at exploiting the tolerance for uncertainty, ambiguity, approximate reasoning, and partial truth in order to achieve tractable, robust, and computationally economic solutions. One question raised in applications of soft computing is the extent to which artificial intelligence (AI) and human intelligence (HI) share similar quantitative or qualitative properties or both. Differences emerge quickly in any comparison of AI and HI. At the same time, despite the clear dichotomy between AI and the first-person perspective in the experience of humans, there are many instances in which human-machine coexistence is increasing (Hamid et al., 2017).

This paper extends the differentiation of AI and HI to include one model of the process of perception and a recognition of the existence of the body for perception, learning, and language. The paper is organized as follows. Section 2 introduces phenomenology as a framework for describing first-person experiences along with James Gibson's (2015) account of information in textured grounds as the source of direct perception (as opposed to traditional accounts in which information processing of stimuli after entering the eye becomes the source of perception). In section 3, we argue for humans' embodied existence in the world as primary in the process of perception and consider its implications in the design of interactive artificial systems. We also examine the role and prevalence of metaphoric language (Section 4), and

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end with a consideration of one application of AI that may have an ethical advantage over HI, namely war robots (Section 5). Whether different aspects of AI and HI are compartmentalized or integrated, the same issues remain – the exercise of judgment, learning, and appropriate decisions.

2 PHENOMENOLOGY

Phenomenology has typically used a figure-ground structure to explain experience in general and perception in particular, applying the methodology to a number of areas of interest (Smith, 2002; Pollio et al., 1997) where nuances of first-person human experience are important. Rubin's vase in Figure 1A is probably the most common example of a figure-ground grouping. James Gibson's (2015) direct perception is one such approach that emphasizes grounds and has impacted the field of ergonomics. His ecological view claims grounds in the environment define the spatial character of the visual world, not what happens to stimuli after entering the eye. In short, information in a textured ground, not objects, explains perception. Gibson was interested in the world as a source of information, not processing mechanisms in the head, which contradicted the centuries-old epistemology of perception as the processing of copies. We perceive space directly from the ground – hence the term direct perception – which in many cases is a continuous surface or an array of adjoining surfaces. Gibson provides examples of optic arrays and looks for patters of optic flow in them such as the experience of changes in the flow when approaching or moving away from a certain point (Figure 1B). Moreover, learning does not merely come from the stimulus-response model in behaviorism. Gibson's conclusions are that all spatial perception is in regard to a textured ground, usually the earth (Gibson, 2015).

The spatial character of the visual world is given not by an analysis of the objects in it but rather by a consideration of the background against which the objects appear and become figural. In addition, most perceivers are in motion either because they are moving in some direction or they are moving their heads. Some information, however, remains constant as an observer moves. Gibson calls these invariants, non-changes that nevertheless persist during a change in the observer. An invariant is a property of the environment that remains constant despite illumination changes or movement of the observer, and Gibson provides over 2 dozen examples in his three books (Goldstein, 1981). In contrast to what Gibson refers to as cognitivism, in Gibson's view no intervening mental processes are necessary and we reject any so-called operations of the mind (mental entities such as sense data). Grounds provide the information necessary for us to perceive directly, and we use such information immediately with no need to transform it. Unlike Gibson's (2015) characterization of the "old idea" that we process sensory inputs and convert them into perceptions – the information processing model in any of its various forms – the extraction of invariants from the stimulus flux is, arguably, a more accurate model of visual perception.

As shown in figure 1C, an observer's movement towards a location results in environmental textures to flow everywhere except the invariant center. To stay on course one needs to keep the unchanging center of the optical flow pattern on the destination. One application of Gibson's model involves pilots landing aircraft in the earlier days of aviation. In some cases airplanes were not stopping soon enough on runways. Gibson determined that the relatively fast or slow flow of the optic array in relation to a fixed point of reference gives the sensation of speed, and that the apparent speed related to one's distance from the ground. Consequently, Gibson explained how pilots in sufficiently high airplanes sensed they were moving slow enough to stop before the runway ended.

Although presented in contrast to information processing and gestalt psychology, Gibson's model of perception is not entirely passive. The role of a moving, embodied active observer is clear throughout his research. In his analysis of active touch, for instance, there is a distinction between active and passive perception. An observer may actively explore the surfaces of objects rather than merely feel an experimenter pushing on one's skin. Bottom-up models of perception where no learning is required, such as that of Gibson, are not applicable to all situations in the same way that any top-down model is not. One theory postulates how the interaction of both bottom-up and top-down processes in a perceptual cycle produces perception and interpretation (Neisser, 1976).

3 EMBODIMENT AND MAURICE MERLEAU-PONTY

It is well understood that AI is particularly adept at fast information processing that involves rules-based logic and can be applied to related forms of computation, such as mortgage underwriting. Pattern recognition (complicated situations when driving, for instance) is better in HI with the development of expert thinking (Levy and Murnane, 2004). Complex communication and ideation are also areas in which

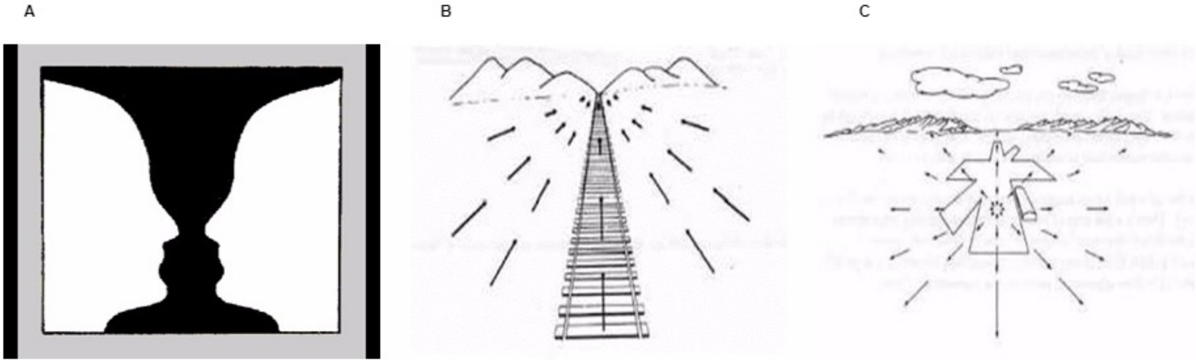

Figure 1: **A:** Rubin's figure. **B:** The pattern of optic flow when looking out of the back of a train. **C:** The point towards which a pilot is moving appears motionless, while the rest of the visual environment appears to move away from that point.

humans are superior owing to the ability to generate new, good ideas and read nonverbal cues in communication. Recently, we have argued that a first-person perspective contributes to the difference between AI and HI (Hamid et al., 2017) on conceptual grounds without reference to perceived embodiment. At this point, an examination of embodiment is warranted, specifically the significance of the body-as-subject. Merleau-Ponty is the best theorist to address the issue of our embodied existence in the world as primary in the process of perception. In his view, our embodied inheritance is more fundamental than our reflexive capacity, and the analytic mode is derivative from the body's immediate exposure to the world (Merleau-Ponty, 1962). Such a first-person perspective reveals the failings of both empiricism and what he calls intellectualism, known as rationalism or idealism. Stated simply, we have a world and access to the world through the body.

When Merleau-Ponty states we are our bodies, he does not understate so-called mental phenomena but rather incorporates the perceiving mind in an incarnated body; using our minds is inseparable from how we are situated physically. In an embodied state of being, the material and ideational are intimately linked in the body-subject that thinks and perceives. Merleau-Ponty stresses the body is not solely an object, merely one of many material components of the world, but is our means of communication with the world (Internet Encyclopedia of Philosophy, 2017). An example he provides is when the left hand touches the right hand while the right hand touches an object; the right hand as object (muscles, flesh) is different from it as a touching subject (Merleau-Ponty, 1962). The body is both perceived object and perceiving subject, if not simultaneously then in an oscillation. Another example is when both hands are pressed together. Either hand can alternate in its role of touching or being touched. It is not the case that one simply has two sensations together, as if grasping two objects next to one another. This ambiguity of touching and touched is representative of the full process of perception. Merleau-Ponty also refers to the reversibility of the body in its ability to be both sentient and sensible (Merleau-Ponty, 1962).

To continue with the emphasis on integration, we can say when the body-subject acts, it is inseparable from when the body-subject perceives. Merleau-Ponty defines understanding as the experience of harmony between an intention and a performance, or what we aim at and what is given to us. Correspondingly, consciousness is better understood as a matter of "I can" instead of "I think that". In short, the lived experience of our bodies denies the differentiation of mind from body and does not allow the detachment of subject from object (Internet Encyclopedia of Philosophy, 2017).

Technology design is one application that comes from a recognition of the role of our experience of the body. Somatics, in this case how it relates to experience in technology, provides embodied approaches to learning and interacting that focus on attention, context, and awareness in order to provide a set of designs that show how to apply somatics (Schiphorst, 2009). Chow and Harrell (2011) use principles in phenomenology along with embodied cognition approaches in cognitive science to examine animated gestural interfaces in creative computing systems. In their approach that centralizes embodied meaning making, they focus on how the sensorimotor experiences of users inform the construction of meaning and how to incorporate this knowledge in the design of interactive systems. The authors claim that to be more engaging, creative computing systems in interactive narrative environments such as video games and computer-based artwork require a new design perspective that allows the use of more evocative gestural interaction. The gist is that bodily motion embodies our intention and should serve as the basis for human-computer interaction (HCI). Such an outlook emphasizes bodily familiarity and cognitive intimacy in the design of creative computing systems, which enables an engagement close in scale to our embodied experiences (Chow and Harrell, 2011).

Considering mechanisms of user input, point-and-click input and ongoing gestural input, Chow and Harrell (2011) are concerned how the separation of gestural input from other kinds of motor input may lead us away from tight sensory-motor connection in HCI. Instead, whether a kind of motor input has a meaningful component of motion, i.e., is intentional in a computational environment, is a more important distinction. Gestural inputs that involve situated, embodied, and evocative motions are more meaningful. One of their examples shows that human-scale embodiment is temporal as well as spatial. The round jog dial of a videotape recorder, or VCR, allows the user to include direction and speed. As with human gestures, the faster the spinning, the more the intention is to hurry. For computer interaction, circling on a touchpad could allow a user to browse through a large database. With practice, more kinds of bodily motion could be spatiotemporal embodiment of intention (Chow and Harrell, 2011). The phenomena of sensory substitution and phantom limbs along with virtual reality, computer games, and overall human-machine interaction are areas in which the experience of embodiment is relevant.

Several other researchers in psychology, neuroscience and other areas have examined embodiment. Chilean biologist Francisco Valera, for instance, popularized neurophenomenology as an emerging field in neuroscience by incorporating the phenomenological method along with an emphasis on embodiment. He co-wrote *The Embodied Mind* to propose a common ground between mind in science and mind in experience (Varela et al., 2017). Specifically related to AI, the embodied approach has been referred to as nouvelle AI, situated AI, behavior based AI, or embodied cognitive science.

4 METAPHORIC LANGUAGE AND GEORGE LAKOFF

George Lakoff and Mark Johnson (2003) have explored the role of metaphorical concepts in how we fundamentally understand, organize, and share the world, and they explicate the experiential grounding, coherence, and systematicity of metaphorical concepts. From this perspective metaphors are primary not only for language but also in human thought processes; they simply dominate cognition. The idea is that our conceptual system is structured metaphorically, and this is why metaphors as linguistic expressions are possible and sensible. Lakoff and Johnson (2003) also demonstrate how an experiential view can explain how metaphors are frequent, organized, and useful, in contrast to schools of thought that neglect the necessity of an experiential basis. Furthermore, metaphors structure our most important concepts such as "education is a journey" and "life is a play". Although the authors' explanations of particular metaphors ("time is money") are not set in stone, to understand metaphors fully one cannot separate them from their experiential base.

In addition to describing basic orientation metaphors such "in vs. out" and "up vs. down" ("rational is up; emotional is down"), Lakoff and Johnson (2003) provide an excellent example of how arguments are equated with battles in different forms in the metaphor "argument is war". As rational animals, and especially in the legal, diplomatic, journalistic and academic worlds, we have institutionally evolved to fight without physical conflict in the form of verbal arguments, although we conceptualize such arguments in the same way as physical battles. Scientists have observed animals challenging, intimidating, attacking, defending, retreating, and surrendering, and human arguments are similar, whether characterized as crude or rational. If I have something to win or lose, I may develop a strategy to shoot down your argument, defend my position, establish territory, counterattack, or convince you to accept my viewpoint. If I am operating from a "lower" level, I may use whatever means I can, such as to threaten, invoke some authority, insult, belittle, evade an issue, bargain, flatter, or even claim to give a rational reason while doing some of these. Of course from a "higher" level, the construction of premises and conclusions in rational argumentation, these are forbidden, yet arguments in this form operate the same way in that you attack and destroy the opponent's position while defending your own in the expectation of victory or even wiping him out if completely successful.

> ... not only our conception of an argument but the way we carry it out is grounded in our knowledge and experience of physical combat. Even if you have never fought a fistfight in your life, much less a war, but have been arguing from the time you began to talk, you still conceive of arguments, and execute them, according to the ARGUMENT IS WAR metaphor because the metaphor is built into the conceptual system of the culture in which you live. Not only are all the "rational" arguments that are assumed to actually live up to the ideal of RATIONAL ARGUMENT con-

> ceived of in terms of WAR, but almost all of them contain, in hidden form, the "irrational" and "unfair" tactics that rational arguments in their ideal form are supposed to transcend. (Lakoff and Johnson, 2003), pp. 63-64.

Examples from *Metaphors We Live By* (Lakoff and Johnson, 2003) that exemplify the path from "high" rational argumentation to everyday, irrational arguments include: (1) it would be unscientific to fail to ... (threat), (2) the work lacks the necessary rigor for ... (insult), (3) your position is right as far as it goes ... (bargaining), (4) the work will not lead to a formalized theory (belittling), (5) in his stimulating paper ... (flattery), (6) Behaviorism has led to ... (challenging authority), (7) Hume observed that ... (authority), and (8) Obviously ... (intimidation).

Moreover, conceptual metaphors such as "knowledge is food" or "social organizations are plants" shape perception and communication. Although different cultures formulate key concepts differently – truth, love, hate, war – our bodies are the basis for much of our everyday thinking and conceptualization of more abstract thought. In this view, we form cognitive models early in development, the basis of which are early sensorimotor experiences. A related discussion of contextual learning of time is found in a previous work by the coauthor of this paper (Hamid, 2015).

The container metaphor is a good example of how we think in spatial terms. A glass contains juice, and we project this metaphor onto something we encounter that is less concrete. For instance, we could use the word *in* to think of something else in the same way, perhaps a tribe that lives in a forest (Lakoff and Johnson, 1999). This process is in stark contrast to computational and representational models of the mind and challenges the concept of truth in humans because from this perspective, truth – or at least comprehension and coherence – is relative to the conceptual system used to understand situations. If our conceptual systems arise from interactions with the environment, it is axiomatic that understanding is always grounded in metaphorical experience.

5 DO WAR ROBOTS GIVE AI AN ETHICAL ADVANTAGE?

Rather than delineate the differences between AI and HI by pointing out the respective advantages of each when working separately or together, it is constructive to present at least one emerging area in which AI may hold a clear advantage: ethics in war involving robots. A look at the literature on the subject shows an acceptance of the inevitability of fully or nearly autonomous weapons and a debate over their partial or total elimination. The views of the USA, China, and Russia regarding robotic weapons appear to be to increase automation while simultaneously emphasizing the continued presence of humans (Guizzo and Ackerman, 2016). Any serious arms-control agreement seems unlikely, and if robotic military systems are here to stay, then a focus on protocols such as the Geneva Conventions and global/local Rules of Engagement (ROE) is warranted so as to highlight the Laws of War (LOW) for international exposure. The creation of an independent robot may be easier than other forms of AI because of the numerous treaties on laws of war that have existed for decades.

Ronald Arkin (2008) is one researcher who believes robots can perform more ethically than human soldiers in certain circumstances because we can program them appropriately. International humanitarian laws, for instance, can become incorporated in robot behavior by translating particular concepts into variables and operations accordingly. Whether it is a Boolean variable of permitted or prohibited use of lethal force, or a determination whether a target is an enemy, Arkin successfully tested his set of algorithms. There is much room for improvement in battlefield ethics, and robotic systems can exercise more restraint when necessary and invariably follow our guidelines to avoid harming civilians (Arkin, 2008). They do not suffer from negative emotions or other factors that cloud judgment, which means they can outperform humans (Guizzo and Ackerman, 2016). Colin Allen provides a diverging view of the ethics of military robots in that programming specific rules would likely work well in an ideal war free of civilians, though this is increasingly rare. Employing machine learning would be preferable, but this is unlikely in the next 50 years (Bland, 2009).

Apart from benefits provided to a military that uses them, such as immunity to biological or chemical weapons, precision, endurance, and persistence, robotic weapons systems could lessen collateral damage by an ability to act conservatively. Unless programmed with self-preservation, there is no need to act when certainty is low. Sensors equipped for battlefield observations and faster integration of information from multiple sources are other factors. In addition, robotic systems do not suffer from scenario fulfillment or cognitive dissonance, and they are even able to monitor independently the behavior of human soldiers or anyone within range of observation, which could lead to a reduction in ethical infractions (Arkin, 2009).

In 2008 the U.S. Navy (Lin et al., 2008) examined multiple issues involving the ethics of robots in a broad report. A quick summary of these follows. With legal challenges, it is unclear who would be assigned blame for harm resulting from an autonomous robot. What would happen when a robot refuses an order, and do soldiers need to give consent to additional risks? Who would give the order to strike if the system is not fully autonomous, and if it is, should we demand 100% accuracy in the identification of a target if human soldiers cannot reach this level? Barriers to start wars could be lowered, and there is imprecision in the LOW and ROE that could easily complicate interpretation. Technical challenges include discrimination among targets and acceptable standards, problems with first-generation models and beta-testing, unauthorized overrides and hacking, competing and possibly inconsistent ethical frameworks in the design stage, coordinated sharing of information before attacks, and the establishment of a chain of command among robots.

Regarding human-robot interaction, there could be effects on squad cohesion if human soldiers are being watched. Robots may need self-defense capabilities, and local populations may not build trust with robots as well as with humans. So-called comfort robots could become a controversial topic of increased scrutiny as well. If military victory is quicker and more dominant with the use of autonomous weapons, then there could be counter tactics resulting from asymmetric warfare as well as proliferation, including into space. Related concerns are our increased dependency on technology and the encroachment of robots into everyday life and the privacy/security dilemma that ensues. Finally, a military could co-opt the work of ethicists to serve its own agenda, robots could or may need to have legal rights, and excessive precaution could slow progress and limit the effectiveness of solutions to many of these concerns (Lin et al., 2008). Regardless of the eventual relevance of the above points, it is clear that the juxtaposition of AI and HI is increasing and the same issues of decision making arise.

6 CONCLUSIONS

What does it mean to learn something? Can we teach wisdom? Is a robot a weapon or does it operate a weapon? The more we can clarify terms, especially those that are particularly emotional, the more understanding emerges. Even a quick look at metaphors reveals how we often structure issues, including in AI, as "technology versus the humanities" or "rationalism versus romanticism" when such projections may not apply. For instance, while there are legitimate concerns about so-called killer robots, there is no mention of any serving in law enforcement, which would immediately change the context and possibly one's perception of threat if abuses by the police are subsequently curtailed. A related consideration is how comfortable we are having automated systems record our own aggression. While it is difficult to conceive of AI either being or having a body or following the developmental progression of human children, there is an emerging trend of increasing integration of AI and HI not only in the design of creative computing systems but also in forms of cooperative coexistence such as increased efficiency with automation in the workplace, playing chess, strategies in professional sports, writing simple news articles, and disease detection in radiology (Hamid et al., 2017).

One utilization of automation that has merged with a human proficiency is commercial piloting. The basic idea is that increased use of automation is supposed to prevent mistakes from human shortcomings, such as fatigue and inattention, and free pilots to think about the big picture and thus improve overall watchfulness and attentiveness. Unfortunately, more automation has led to more mind-wandering such that lack of monitoring has become a factor in the majority of accidents. Although it is difficult to identify and assess complacency and boredom, it is simple to conclude that pilots need to pay attention and properly monitor the controls when employing autopilot (Konnikova, 2014). It appears that automation has not reduced the number of errors, but it has changed their form. A smoother integration would involve taking into account the way pilots' minds operate when introducing and innovating forms of automation. This is an immensely practical application of successful coexistence. One study (Casner et al., 2014) tested how the prolonged use of cockpit automation affected the manual flying skills of pilots, based on a concern of potential deterioration resulting from the adoption of a more supervisory role after the increased employment of automation systems. The results showed that while some skills remained intact, even if infrequently practiced, certain cognitive tasks needed to fly the plane manually were more problematic. Crucially, performance on these tasks was associated with how often pilots were inattentive when using cockpit automation. Again, a more detailed understanding of the mechanisms at work in the coordination of AI and HI allows us to acknowledge problems and implement solutions in various subfields, which is already happening (Hamid, 2017).

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